Informational Leaflet 54

ABUNDANCE, SIZE AND AGE OF RED SALMON SMOLTS

FROM THE WOOD RIVER SYSTEM, 1964

By:

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INTRODUCTION

The Wood River lakes system constitutes the main spawning area for red salmon (*Oncorhynchus nerka*) in the Nushagak District. In view of the importance of this area as a producer of red salmon, a smolt enumeration and sampling program was initiated at the outlet of Lake Aleknagik in 1951 by the Fisheries Research Institute of the University of Washington.

The Alaska Department of Fish and Game assumed the responsibility for the smolt program in 1961 and has continued the project without major modification in fishing methods. The 1964 season was the Department's fourth consecutive year of operating the program.

The life history of the red salmon is spent in two distinctive environments; freshwater and saltwater. This separation allows the convenient division of fluctuations in abundance into those which occur in freshwater, at sea and as a result of the fishery.

The number of seaward migrants as related to the number of parent spawners gives a direct measure of production of young. This relationship provides a measure of the variability in freshwater survival rates and the possible existence of cyclic patterns in freshwater survival. With the information gained from the seaward migrant studies, forecasts of adult returns from seaward migrations are made.

This report is a summary of the data obtained in 1964. Procedures used in determining abundance, size, age, and migration timing of Wood River smolts are fully discussed.

OBJECTIVES

The primary objective is to measure the relative abundance of red salmon smolts migrating seaward from the Wood River lakes by establishing a numerical index which is comparable from year to year. Other objectives are as follows: (1) to study the diurnal fluctuations and seasonal timing of the migration; (2) to study the age and size composition of the run; (3) to measure the condition factor of the smolts; (4) to evaluate the relationship of smolt production and adult escapement levels.

DESCRIPTION OF THE AREA

The four main lakes of the Wood River system lie on a general east-west axis bordered on the west by the Wood River Range (Figure 1).

The four piedmont lakes are of glacial origin and are ice-covered for approximately 6 months of the year. The four lakes cover approximately 174 square miles (Nelson 1964a), and are joined by short rivers, with the 25 mile-long Wood River connecting the lowest lake with Nushagak Bay. The 350 foot wide Wood River drains a basin of approximately 1,415 square miles. The flow, which was taken throughout the summer season, varies from 4,812 to 11,520 cubic feet per second.

The annual average precipitation recorded at Dillingham over a period of 35 years was 26.9 inches (U.S. Army Corps of Engineers 1957). The average annual snowfall is about 65.4 inches while the mean annual temperature is 34.1° F (Mertie 1938).

Escapements of red salmon over the 12-year period 1953-1964 have averaged 904,057 and have varied from 288,727 in 1957 to 2,209,266 in 1959.

The smolt sampling site is located on a gravel shoal at Mosquito Point on the outlet of Lake Aleknagik (Figure 1).

METHODS

Fyke Net Design

A fyke net constructed of 1/2 inch mesh nylon webbing throughout was used to trap the smolts. The net was hung from a solid steel frame 4 foot square and was provided with two 10-foot lead-in wings (Figure 2). The two wings were held open by the force of the river current and two connecting spacer lines allowed the net to fish a consistent 9-foot wide section of the river.
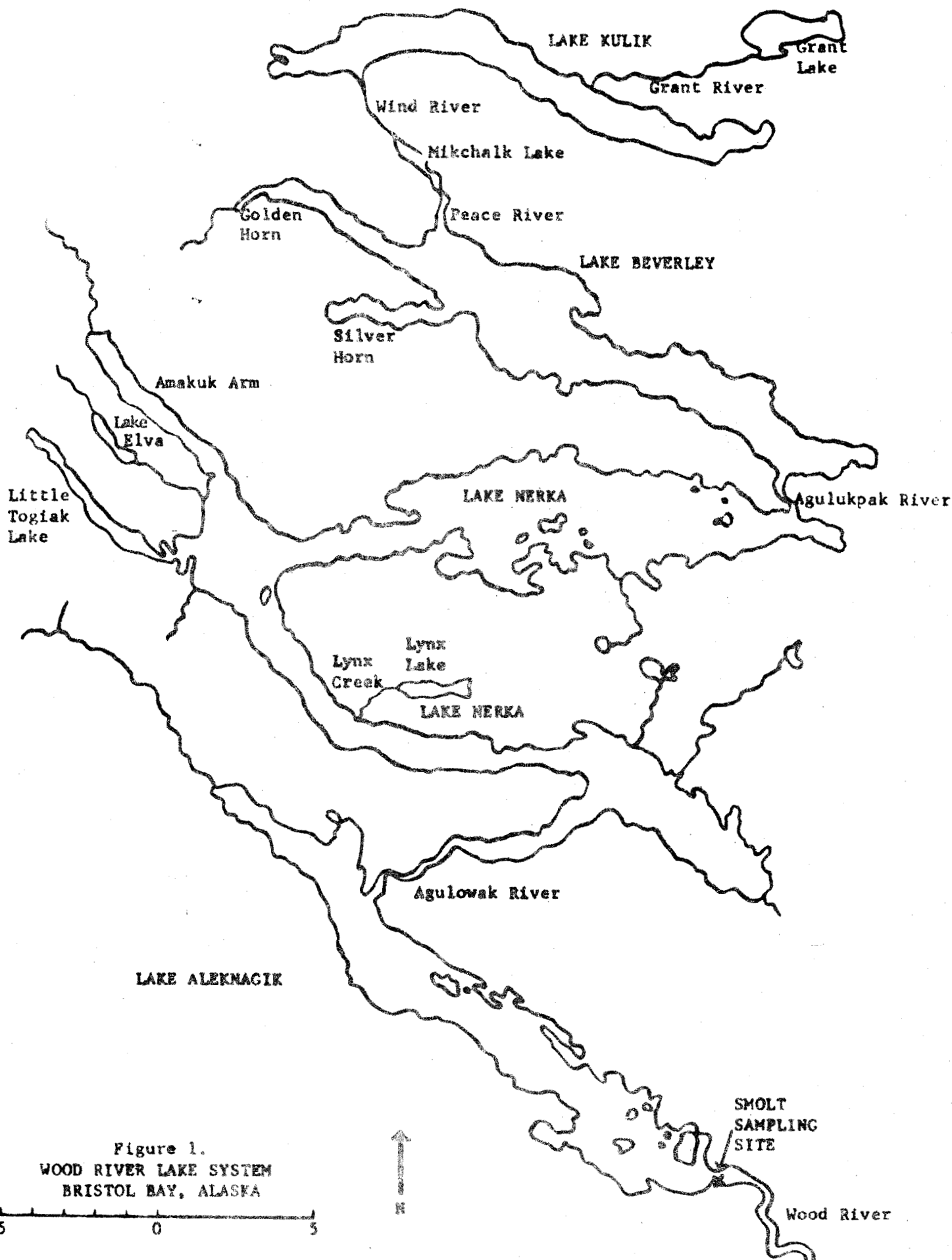
The body of the net tapered from the frame to a single rectangular funnel 2" by 10" at the throat. A second funnel of the same dimensions was located in the detachable cod-end. A heavy duty zipper facilitated in emptying the catch from the cod-end.

A safety trip mechanism was installed between the outshore anchor line and the bridle line of the fyke net, which allowed the net to be "tripped" in a matter of seconds when the need arose.

Fyke Netting Procedure

The fyke net was set before 9 p.m. each night and commenced fishing on the hour. The net was tended from an 18-foot skiff by two or more men.

To check the catch, the cod-end was detached by removing a single locking pin. An empty cod-end was immediately put in place before the net was lowered back into the water.

LAKE KULIK

Grant Lake

Grant River

Wind River

Mikchalk Lake

Golden Horn

Peace River

LAKE BEVERLEY

Silver Horn

Amakuk Arm

Lake Elva

Little Togiak Lake

LAKE NERKA

Agulukpak River

Lynx Creek

Lynx Lake

LAKE NERKA

Agulowak River

LAKE ALEKNAGIK

SMOLT SAMPLING SITE

Wood River

Figure 1.
WOOD RIVER LAKE SYSTEM
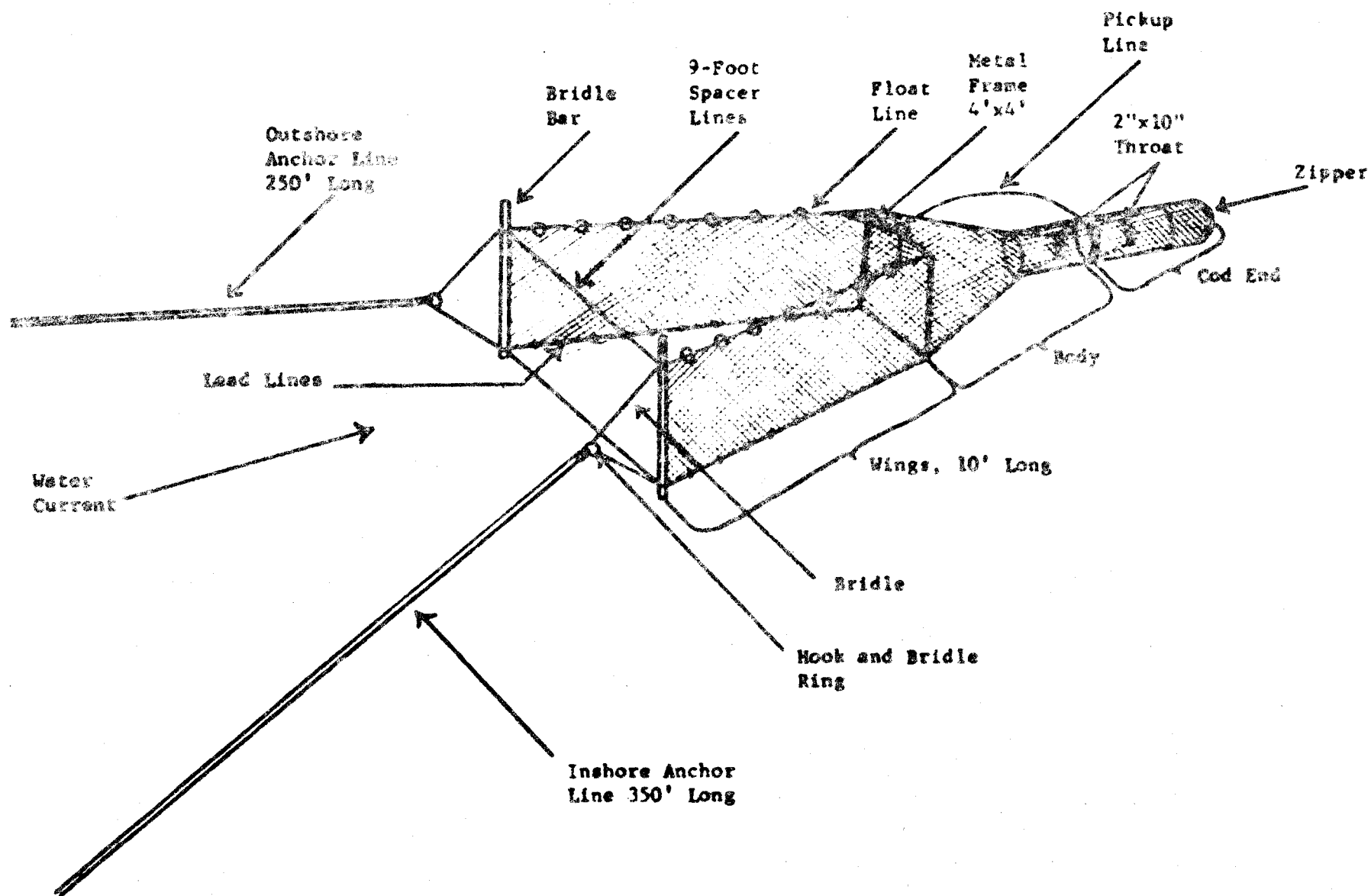BRISTOL BAY, ALASKA

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Figure 2. Nylon fyke net used to sample red salmon smolts, Wood River, 1964.

If the catch was small, the smolts were counted by hand and returned immediately to the river. If the catch was over 5 pounds, they were placed in a large weighing basket that was immersed in a tub of water. The weighing basket was then removed from the tub and hung on a spring balance of 60-pound capacity suspended from a weighing stand in the skiff. The total catch in pounds and tenth of pounds was then recorded from each cod-end check during each night's fishing. When the catches were weighed, 1-pound sample counts were made in order to convert total weight into numbers of fish. Fish were released at the fyke net site except when specimens were needed for parasite, condition of scale studies.

Collection of Biological and Physical Data

A representative sample of smolts was saved from each cod-end check and placed in containers. At the end of the fyke netting index period, a 1-pound sub-sample was taken for each hour that the net fished. These fish were anesthetized in MS-222 *(Tricaine methanesulfonate)*, measured (snout to tail-fork), and returned to the water unharmed.

In addition to measuring each smolt in the 1-pound sub-sample, each fish was examined for parasites.

Individual length, weight, and scales were taken from 20 fish from each night's peak hourly catch. Weights were taken on a Ohaus triple beam balance and recorded in grams to the nearest tenth. Length was recorded in millimeters, and scales were taken from each fish and placed on microscope slides for later reading.

Condition samples were taken approximately every third night during the early and late portion of the smolt outmigration and every night during the peak of the migration.

Air and water temperatures, water level, precipitation, wind direction, and velocities were determined daily with a maximum-minimum air thermometer and pocket thermometer, water level gauge mounted in the river, rain gauge, and a Dwyer wind meter, respectively.

General weather observations and water color were recorded daily, while the river flow in cubic feet per second was recorded once per week.

OUTMIGRATION RESULTS

Fishing Schedule and Site

The fyke net was fished each night from 9 p.m. to 11 p.m., the previously established index hours. In addition to the nightly index schedule, 24-hour counts were conducted throughout the season at random intervals to show the relationship between diurnal and nocturnal migrations. Field operations commenced on June 6 and continued through July 20.

Breakup of lake ice occurred on June 15-16, which is 2 weeks later than the normal date for breakup on Lake Aleknagik (Table 1).

Table 1. Relationship between dates of breakup of ice on Lake Aleknagik and
early-season seaward migration of red salmon smolts at Wood River
index site, 1951-64.

Year[1]	Breakup date Lake Aleknagik	Date 5% of migration over	Date 10% of migration over	Date 20% of migration over
1958	May 14	June 8	June 9	June 13
1954	May 26	June 1	June 2	June 2
1953	May 27	May 31	June 3	June 11
1957	May 28	June 2	June 7	June 12
1951	May 30	June 4	June 7	June 9
1961	May 30[2]	June 4	June 5	June 8
1960	May 31	June 2	June 3	June 7
1959	June 1[2]	June 4	June 6	June 7
1956	June 1-3	June 10	June 12	June 15
1962	June 1-3	June 13	June 13	June 15
1963	June 3	June 4	June 11	June 11
1952	June 7	June 11	June 12	June 14
1955	June 10	June 23	June 26	June 29
1964	June 15-16	June 15	June 21	June 23
Range	May 14 - June 16	May 31 - June 23	June 2-26	June 2-29

[1] Years listed in order of breakup date.

[2] Approximate date.

This year's breakup was the latest ever recorded during the 14-year history of the smolt program and is one of the latest breakups ever encountered at Lake Aleknagik.

Large and small floes of ice in the river hindered fishing operations for the first week.

The location of the fyke net remained at the previously established index site, the south shore of Lake Aleknagik at Mosquito Point. The position of the net varied according to fluctuation of lake level, maintaining, in general, a depth of just less than 4 feet.

The late ice breakup on Lake Aleknagik in 1964 resulted in a rapid rise in the water level at the fyke net site (Figure 3). Consequently, the net needed readjustment daily to a position farther inshore. When the lake waters began to recede after June 18, the process was reversed. Readjustment of the fyke net was made by relocating the anchors or adjusting the anchor lines.

Index of Abundance

The total catch of red salmon smolts during the index hours for the entire season was 966,807 (Table 2). Using 1952 as the base year with the assigned value of 100.00 index points, the 1964 season catch was equivalent to 568.60 index points (Tables 2 and 6).

The 1964 smolt outmigration was the largest migration recorded during the 14-year old program. The smolt catch of July 1 amounted to 197,237 which was greater than the total smolt catch for the entire season in 1963. Figure 4 shows in graph form the relative magnitude of the smolt runs in the Wood River system from 1951 through 1964.

The 1964 index is well above the average index value of 173.4 obtained over a 14-year period (Table 6). The peak of the migration occurred on July 1, when 197,237 smolts were caught during the index hours; however, heavy migration occurred throughout the season from June 21 to July 5 (Figure 5).

Timing of the Migration

Random 24-hour sampling conducted throughout the season gave evidence that over 67 percent of the season's migration passed the fyke net site during the index hours, 9 to 11 p.m. (Table 3). During the 7 days of around-the-clock fishing, over 91 percent of the smolts were caught during the evening period from 9 p.m. to 2 a.m. (Table 3).

The catches during the index hours followed the usual pattern. Migration was lowest during the first hour (38.81%) and increased during the second hour (61.19%). The proportion of the catch taken early in the evening has been consistent from year to year, thus giving evidence to the reliability and consistency of the smolt index method.

The influence of climate plays a very important role in the timing of the seaward migration at Wood River. In lake systems that freeze over, such as the Wood
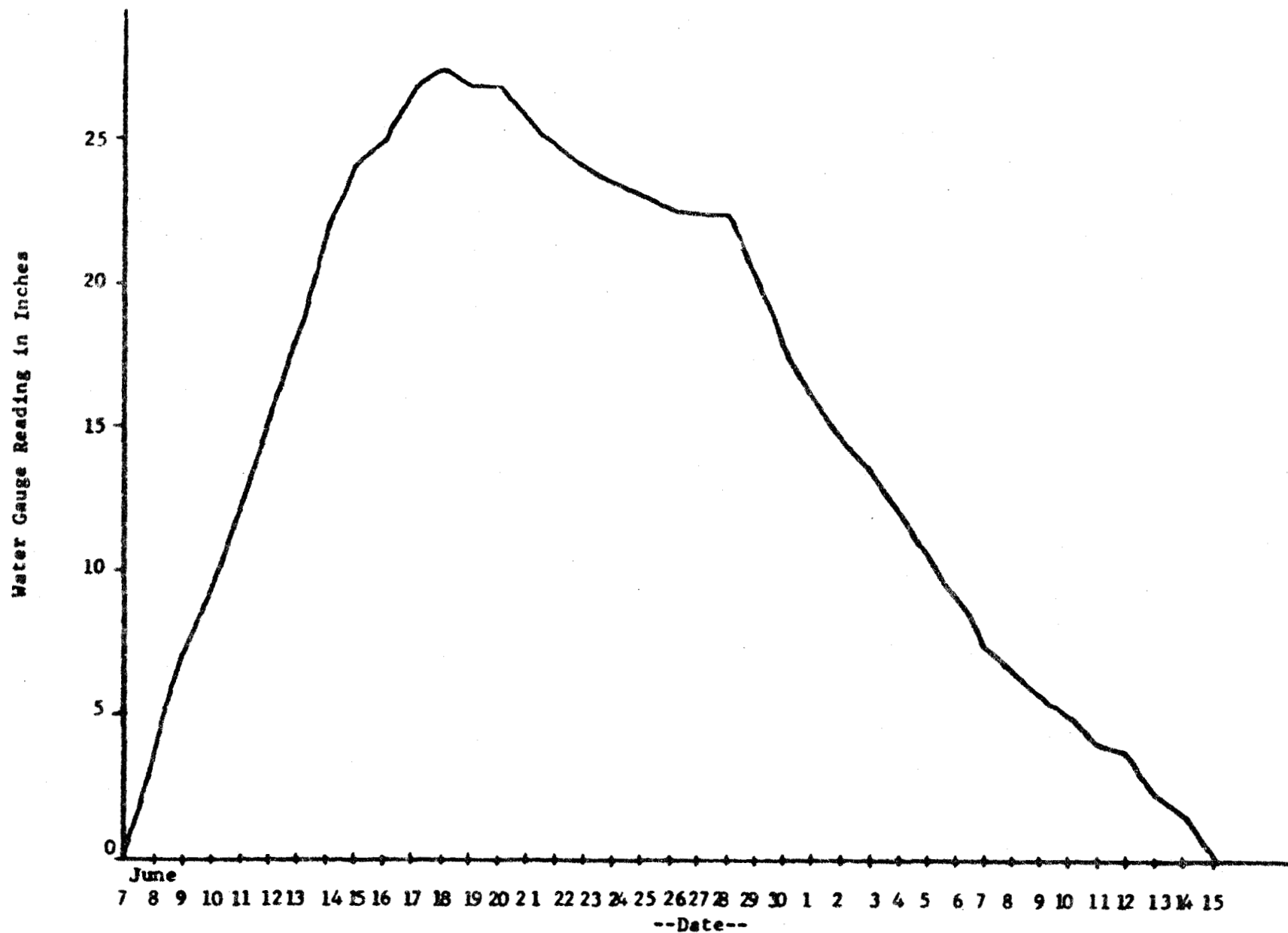
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Figure 3. Wood River water gauge readings in inches and tenth of inches, 1964. (Water level measured from a fixed bench mark on the bank).

Table 2. Wood River red salmon smolt catch by hour and day, 1964.

Date		Index Hour Catch		Total Index Catch		Index Points[1]	
		9-10 p.m.	10-11 p.m.	Daily	Cumulative	Daily	Cumulative
June	6	1,158	3,344	4,502	4,502	2.65	2.65
	7	12	6	18	4,520	0.01	2.66
	8	637	965	1,602	6,122	0.94	3.60
	9	154	236	390	6,512	0.23	3.83
	10	1,860	1,884	3,744	10,256	2.20	6.03
	11	164	124	288	10,544	0.17	6.20
	12	2,334	4,956	7,290	17,834	4.29	10.49
	13	2,291	7,003	9,294	27,128	5.47	15.96
	14	5,327	12,322	17,649	44,777	10.38	26.34
	15	927	2,432	3,359	48,136	1.98	28.32
	16	3,033	9,084	12,117	60,253	7.13	35.45
	17	0	20	20	60,273	0.01	35.46
	18	864	6,552	7,416	67,689	4.36	39.82
	19	187	882	1,069	68,758	0.63	40.45
	20	45	1,043	1,088	69,846	0.64	41.09
	21	3,606	72,369	75,975	145,821	44.68	85.77
	22	0	0	0	145,821	0.00	85.77
	23	62,188	59,614	121,802	267,623	71.63	157.40
	24	543	3,145	3,688	271,311	2.17	159.57
	25	6,217	5,374	11,591	282,902	6.82	166.39
	26	2,033	4,045	6,078	288,980	3.57	169.96
	27	1,388	35	1,423	290,403	0.84	170.80
	28	27,699	28,641	56,340	346,743	33.13	203.93
	29	77,750	27,464	105,214	451,957	61.88	265.81
	30	14,521	35,506	50,027	501,984	29.42	295.23
July	1	82,223	115,014	197,237	699,221	116.00	411.23
	2	3	9	12	699,233	0.01	411.24
	3	41,512	101,513	143,025	842,258	84.12	495.36
	4	1,657	63	1,720	843,978	1.01	496.37
	5	13,110	72,336	85,446	929,424	50.25	546.62
	6	480	2,205	2,685	932,109	1.58	548.20
	7	2,680	5,601	8,281	940,390	4.87	553.07
	8	6,595	2,463	9,058	949,448	5.33	558.40
	9	7,773	657	8,430	957,878	4.96	563.36
	10	2,729	231	2,960	960,838	1.74	565.10
	11	0	38	38	960,876	0.02	565.12
	12	0	573	573	961,449	0.34	565.46
	13	316	807	1,123	962,572	0.66	566.12
	14	1	8	9	962,581	0.01	566.13
	15	521	592	1,113	963,694	0.65	566.78

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Table 2. Wood River red salmon smolt catch by hour and day, 1964 (continued).

| Date | Index Hour Catch | | Total Index Catch | | Index Points[1] | |
	9-10 p.m.	10-11 p.m.	Daily	Cumulative	Daily	Cumulative
16	323	20	343	964,037	0.20	566.98
17	243	1,801	2,044	966,081	1.20	568.18
18	45	361	406	966,487	0.24	568.42
19	8	122	130	966,617	0.08	568.50
20	31	159	190	966,807	0.10	568.60
Totals	375,188	591,619	966,807	966,807	568.60	568.60
Percent	38.81	61.19	100.00			

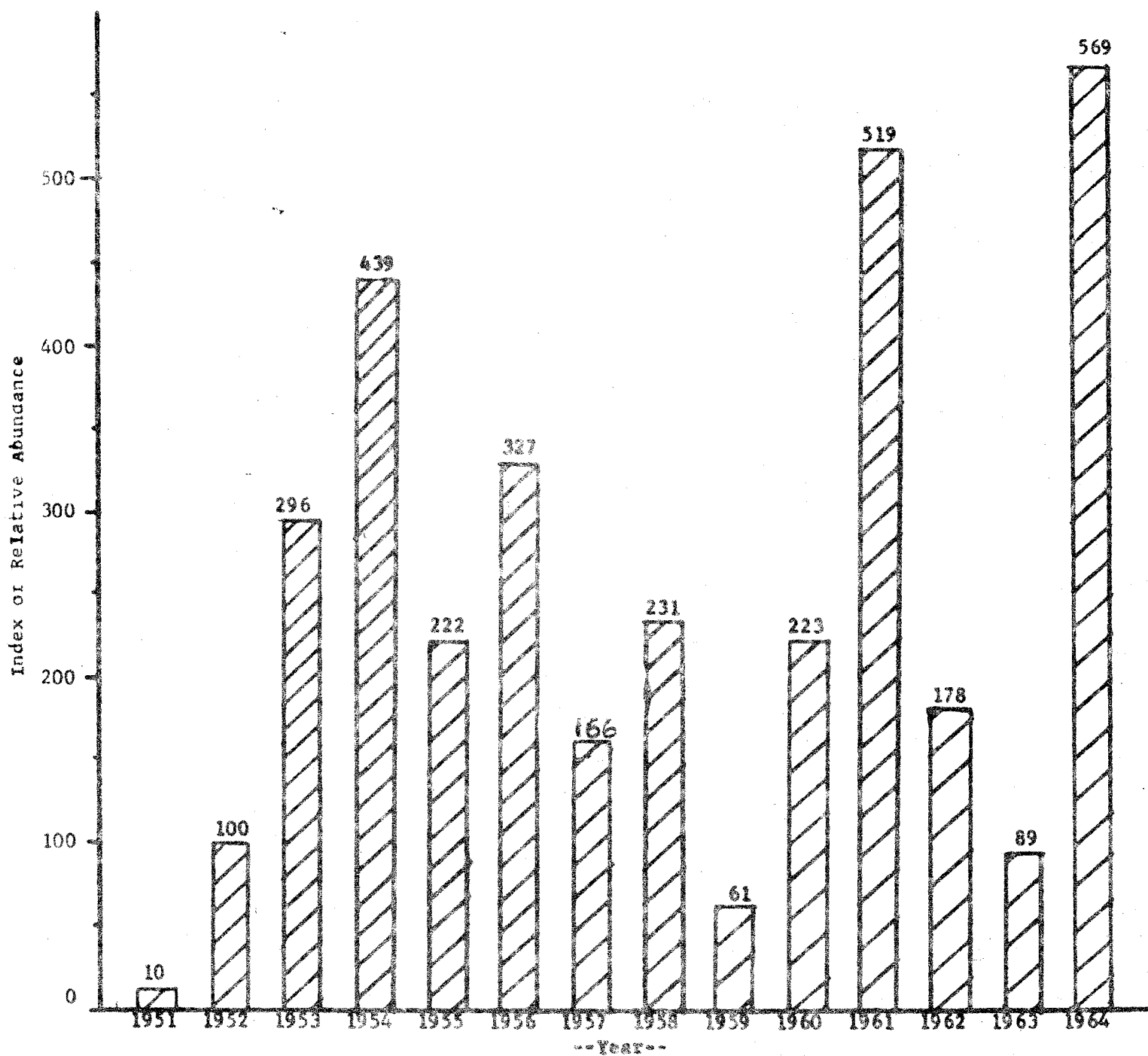[1] One index point = 1,700.34 smolt.

Figure 4. Relative magnitude of red salmon smolt outmigrations from the Wood River system, 1951-1964.
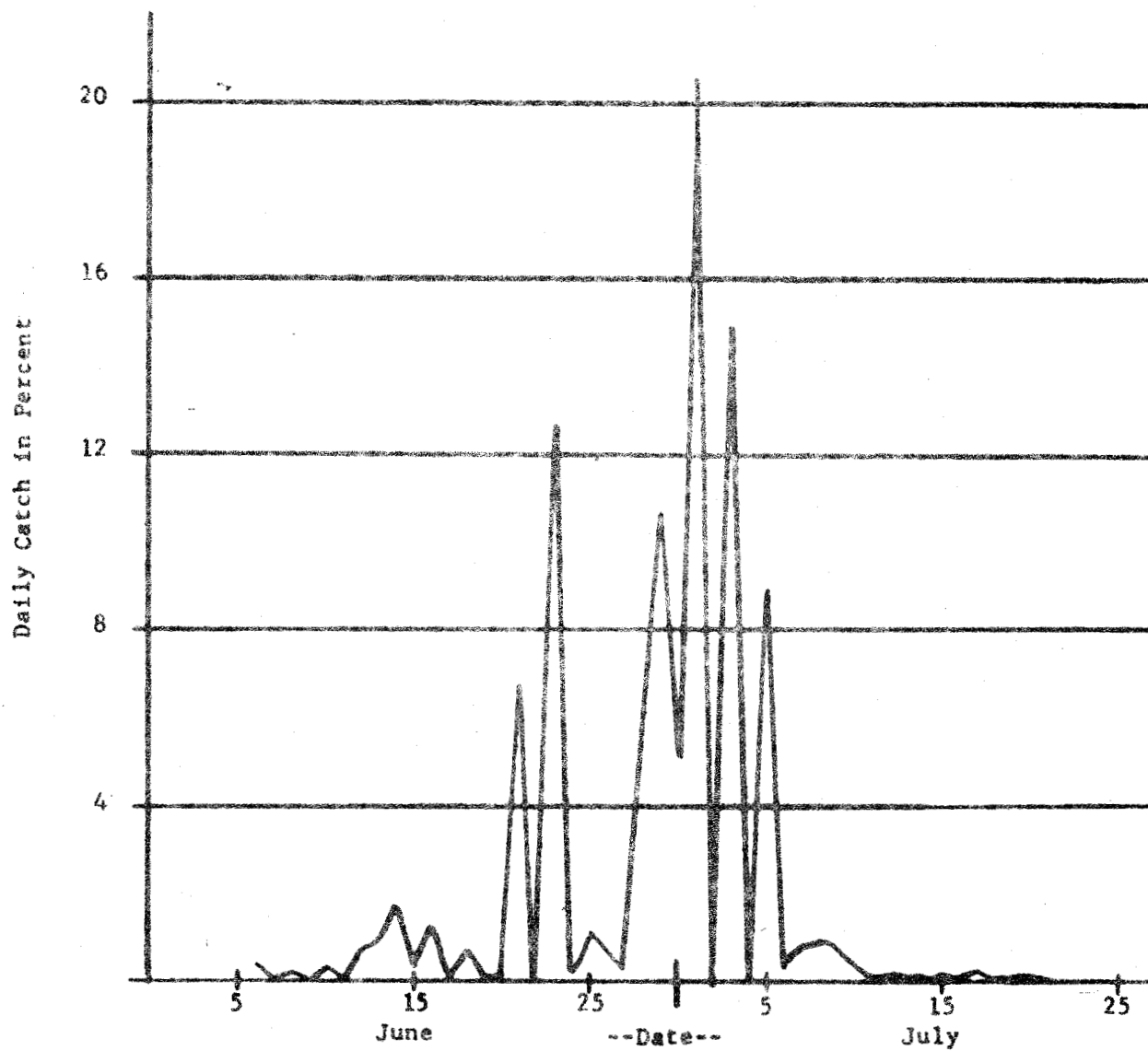
Figure 5. Daily catches of red salmon smolt in percent of total catch, from the Wood River system, 1964.

Table 3. Wood River red salmon smolt catch in index net over 24-hour period, 1964.

Time Period	June 17-18	June 18-19	June 23-24	June 29-30	July 4-5	July 18-19	July 19-20	Total	Percent
9-10 p.m.	0	864	62,188	77,750	1,657	45	8	142,512	40.60
10-11 p.m.	20	6,552	59,614	27,464	63	361	122	94,196	26.83
11 p.m.-12 mn.	171	3,182	16,834	5,094	207	76	133	25,697	7.32
12 mn.-1 a.m.	964	5,315	13,251	2,780	208	22	6	22,546	6.42
1-2 a.m.	1,085	12,428	15,228	9,083	50	3	1	37,878	10.79
2-3 a.m.	853	2,260	5,529	922	10	34	5	9,613	2.74
3-4 a.m.	2	60	1	12	37	22	6	140	0.04
4-5 a.m.	0	19	2	0	1	0	27	49	0.01
5-6 a.m.	0	5	0	0	0	0	0	5	0.00
6-7 a.m.	0	2	0	1	0	0	0	3	0.00
7-8 a.m.	0	0	1	1	0	0	0	2	0.00
8-9 a.m.	0	2	0	1	0	0	0	3	0.00
9-10 a.m.	0	0	2	0	0	0	0	2	0.00
10-11 a.m.	0	1	0	0	0	0	0	1	0.00
11 a.m.-12 n.	0	0	0	0	0	0	0	0	0.00
12 n.-1 p.m.	0	2	1	2	445	0	0	450	0.13
1-2 p.m.	0	1	0	0	1	0	0	2	0.00
2-3 p.m.	0	0	2	0	210	0	0	212	0.06
3-4 p.m.	0	0	0	0	442	0	0	442	0.13
4-5 p.m.	1	2	0	0	2,572	0	0	2,575	0.73
5-6 p.m.	0	0	0	0	1,275	0	41	1,316	0.37
6-7 p.m.	1	0	0	10	1,271	0	1	1,283	0.37
7-8 p.m.	84	0	8	236	20	0	1	349	0.10
8-9 p.m.	155	4	280	3,999	7,318	3	0	11,759	3.35
	3,336	30,699	172,941	127,355	15,787	566	351	351,035	100.00

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River system, differences in timing of migration are associated with differences among years in dates of breakup of lake ice (Table 1).

Other influences which appear to contribute to the timing of migration in the Wood River lakes are: (1) changes in relative numbers in the sub-population of smolts from the lakes (2) differences between size and age of smolts to be discussed later), and (3) differences in rates of growth in early summer.

Again, as in previous years, the beginning of heavy seasonal migration was delayed until the lake outlet water temperatures reached 38° - 39° F. Cessation of heavy seaward migration on the Wood River system from 1952 to 1957 coincided with warming of lake waters to over 50° F (Burgner 1962).

Daily water temperatures taken in 1964 at the fyke net site showed that cessation of seaward migration was associated with rising water temperatures. Cessation of heavy seaward migration occurred on July 6 at which point the water temperature rose to over 50° F for the first time.

Size and Age Composition

Length frequencies and age data were grouped into nine 5-day periods extending from June 6 through July 20. The number of smolts caught in each period, percentage of the season's catch by period, number of samples taken, number of fish measured, and the number of scales read are shown in Table 4.

Size composition was determined from length measurements of 5,984 smolts contained in 68 one-pound samples. Age determination was based on readings of 780 scales contained in 39 scale samples (Table 4).

In computing length frequency curves, daily samples were weighted by the daily catches they represented to adjust for changes during the season in the magnitude of catches.

Combined weighted length frequencies for each period are shown in Figure 6, with the dividing line between Age I and Age II smolts as determined from scale readings indicated by vertical dashes. These frequencies were calculated in percentages.

The season's weighted length frequency distribution is shown in Figure 7.

Immediately apparent from the data presented in Figure 6 is the tendency of the yearling migrants to decrease in average length and weight as the season progresses. The trend is reversed after July 10, when the rapid new summer growth begins to show itself in increased growth.

A pattern of general decrease in size of smolts during the evening was also evident in the samples. This pattern may be due to the following reasons: (1) larger fish reaching the lake outlet have a greater migration stimulus because of their more advanced development, or (2) that the final distance from the daytime milling area to the lake outlet is traveled more swiftly by the larger, stronger swimming fish (Burgner 1962)

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Table 4. Wood River red salmon smolt sampling data, 1964.

| Period no.	Date	Smolt catch	Percent of season's total	No. of 1 lb samples measured	No. of fish measured	No. of scales read
1	June 6 - 10	10,256	1.06	7	525	80
2	June 11 - 15	37,880	3.92	9	716	100
3	June 16 - 20	21,710	2.25	7	553	80
4	June 21 - 25	213,056	22.04	8	671	80
5	June 26 - 30	219,082	22.66	9	835	100
6	July 1 - 5	427,440	44.21	7	679	80
7	July 6 - 10	31,414	3.25	10	1,028	100
8	July 11 - 15	2,856	0.29	5	466	60
9	July 16 - 20	3,113	0.32	6	511	100
		966,807	100.00	68	5,984	780
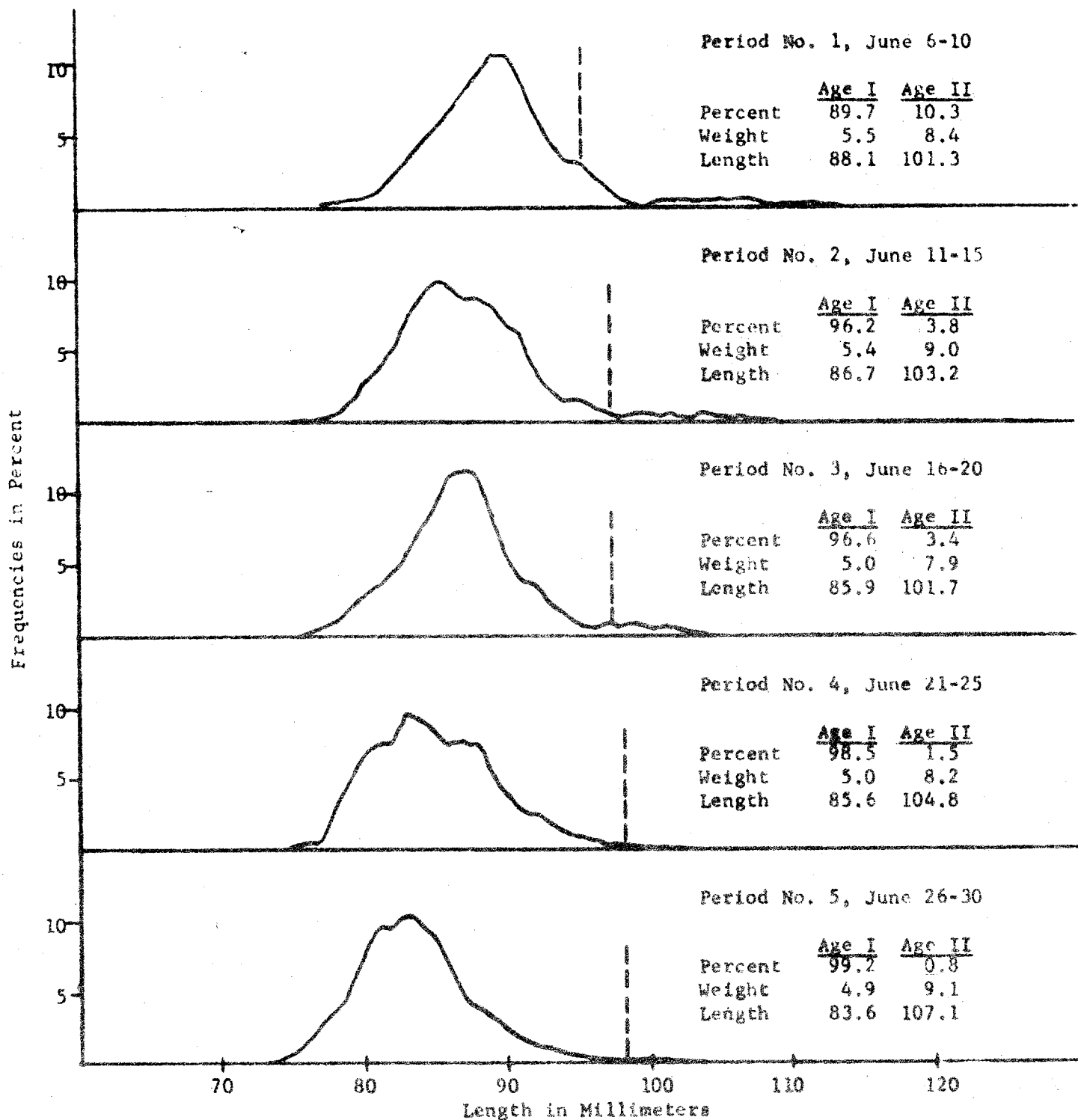
Figure 6. Weighted length frequencies of red salmon smolt from the Wood River system, 1964. (Verticle dash lines divide Age I and Age II). (Frequencies smoothed by moving averages of threes)
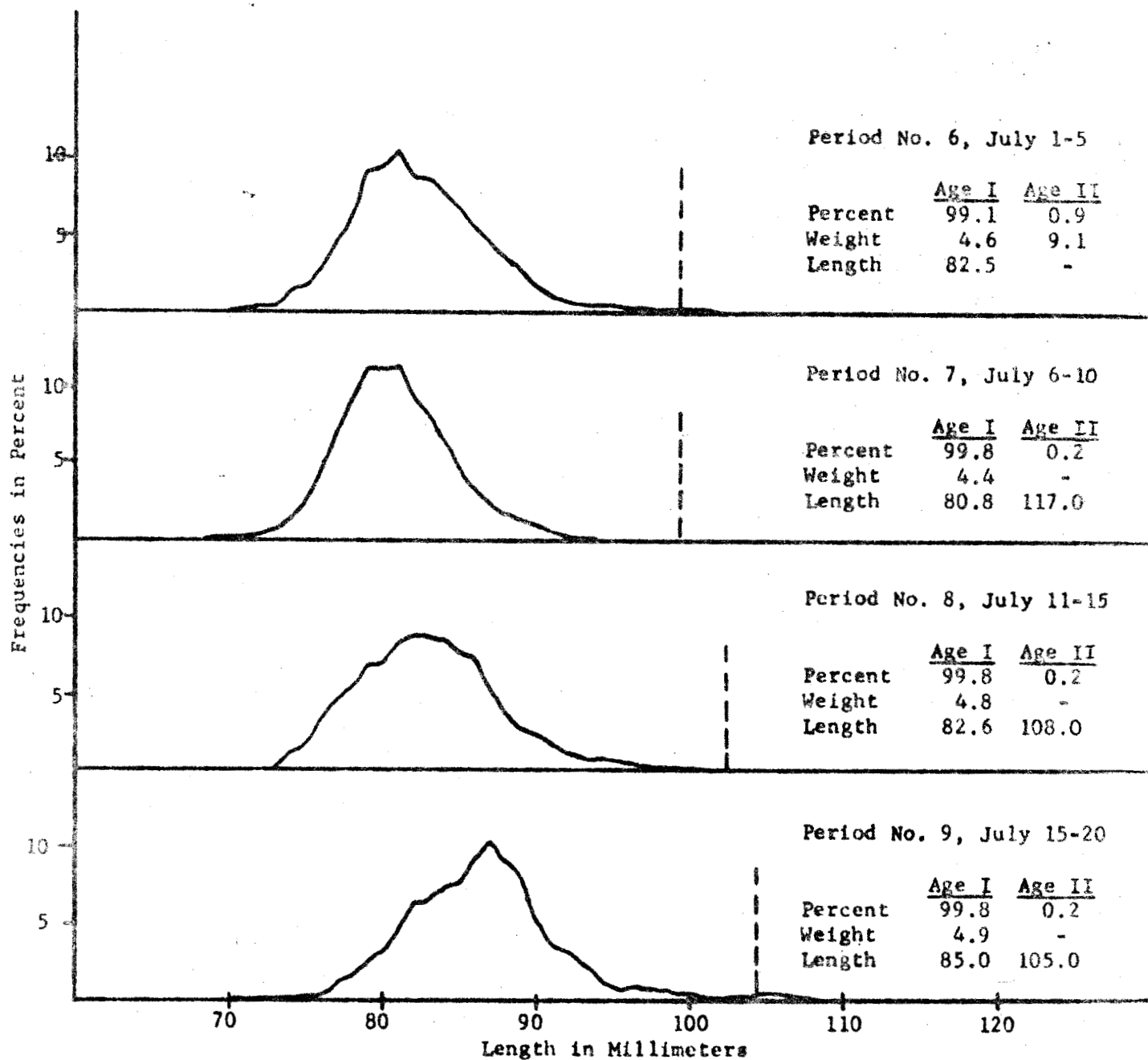
Figure 6 (continued). Weighted length frequencies of red salmon smolt from the Wood River system, 1964.
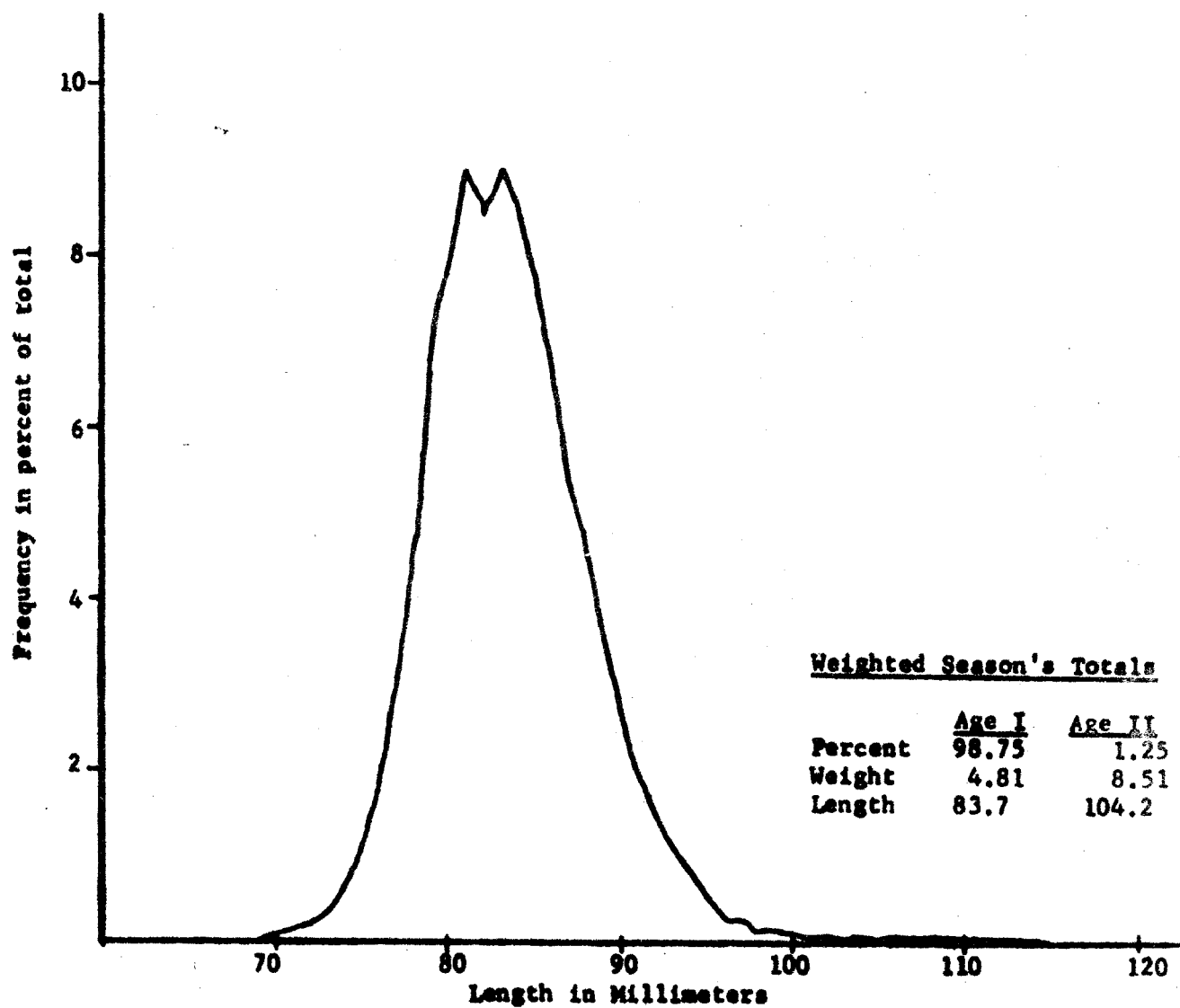
Figure 7. Season's weighted length frequency of red salmon smolt from the Wood River system, 1964. (Frequencies smoothed by moving averages of threes.)

The chart has a y-axis labeled "Frequency in percent of total" with values 2, 4, 6, 8, 10, and an x-axis labeled "Length in Millimeters" with values 70, 80, 90, 100, 110, 120.

Inset table:

Weighted Season's Totals

	Age I	Age II
Percent	98.75	1.25
Weight	4.81	8.51
Length	83.7	104.2

The percentage and mean length and weight of each age group were calculated for each period and for the entire season (Table 5). Age I smolts (fish that have spent one winter in freshwater) comprised 98.75 percent of the total run and averaged 83.7 mm in length and 4.81 grams in weight; Age II smolts (fish that have spent two winters in freshwater) comprised 1.25 percent of the run and averaged 104.2 mm in length and 8.51 grams in weight (Table 5).

Age II smolts represented a very small proportion of the total run. Only 12,078 or 1.25 percent of the total index catch were smolt that had spent two winters in freshwater.

The fluctuations in the mean length and weight, by period, of Age II smolts is due to the small numbers in each night's catch and the correspondingly small samples obtained.

Table 6 summarizes the comparative age, length, and index catches for the years 1951 through 1964.

Condition Index of Smolt

The condition index of the 1964 smolt run was calculated on the basis of weight per fish of a given length. Sixteen 2 to 4-pound condition samples were taken randomly throughout the season. Fish were measured in millimeters and collected in 3 mm groupings. Each group of fish was weighed in grams and weight per fish was calculated (Table 7).

The average length and weight of both smolt age groups, as compared to the previous 3 years, is shown in Table 8. The Age I smolts approached very closely the length and weight of the 1963 smolt, and were comparable with the mean 4-year average. The Age II smolts were longer and weighed less than the 1963 smolt.

The relationship between the length and weight of the 1964 smolt migration is shown in Figure 8.

All of the smolts anesthetized and measured (5,984) were examined for the parasitic cestode, *Triaenophorus crassus*. The plerocercoid stage of this cestode has been found on occasion to be detrimental to other species of fish, and may affect young red salmon (Burgner 1962). During the development and encystment of the plerocercoid stage, considerable musculature is destroyed. Even though direct proof is lacking that the cestode is a serious mortality factor in red salmon smolt, the parasite is prevalent enough to be worthy of attention.

It was found that 54.43 percent of the 1964 smolts were infested by the parasite (Table 9). The 1974 percent of parasitism is the highest infestation in the last 4 years, but is below the average annual incidence of 66.00 percent for the years 1948 through 1958 (Burgner 1962).

Smolt Production Versus Escapement Levels

The 1964 smolt run originated from the adult escapements of 461,000 in 1961 and 874,000 in 1962.

Table 5. Age[1], length[2], and weight[3] of red salmon smolts by 5-day period from the Wood River system, 1964.

Period no.	Date	Line dividing Age I & Age II	Mean length of age group I	Mean length of age group II	Mean weight of age group I	Mean weight of age group II	Percentage of age group I	Percentage of age group II
1	June 6 - 10	95.5	88.1	101.3	5.53	8.44	89.71	10.29
2	June 11 - 15	97.5	86.7	103.2	5.42	8.95	96.23	3.77
3	June 16 - 20	97.5	85.9	101.7	5.03	7.92	96.56	3.44
4	June 21 - 25	98.5	85.6	104.8	5.02	8.16	98.51	1.49
5	June 26 - 30	98.5	83.6	107.1	4.88	9.08	99.16	0.84
6	July 1 - 5	99.5	82.5	103.3	4.61	9.13	99.12	0.88
7	July 6 - 10	99.5	80.8	117.0	4.39	--	99.81	0.19
8	July 11 - 15	102.5	82.6	108.0	4.84	--	99.79	0.21
9	July 16 - 20	104.5	85.0	105.0	4.92	--	99.80	0.20
Season's weighted total[4]			83.7	104.2	4.81	8.51	98.75	1.25

[1] Number winters in freshwater.

[2] Length in mm.

[3] Weight in grams.

[4] Weighted by index catch.

Table 6. Comparative age, length, and index net catches of red salmon smolt from the Wood River system, 1951-64[1].

| Year of seaward migration | Age I[2] | | Age II[2] | | Index[5] points | Index net catch |
	Percent	Mean[3] length	Percent	Mean[3] length		
1951	80.0	91.0	20.0	-	9.9	16,809
1952[4]	99.0	87.0	1.0	-	100.0	170,034
1953	95.3	86.0	4.7	103.0	296.1	503,444
1954	95.8	87.0	4.2	107.0	438.6	745,832
1955	98.0	85.0	2.0	102.0	221.7	377,032
1956	78.4	82.0	21.6	95.0	326.6[6]	559,932
1957	80.7	77.0	19.3	93.0	165.5[6]	244,831
1958	65.0	82.0	35.0	102.0	230.9[6]	423,580
1959	93.5	87.9	6.5	105.0	60.5[5]	100,450
1960	99.4	88.0	0.6	114.0	223.3	379,668
1961	93.0	81.7	7.0	102.1	518.7	881,911
1962	86.0	80.1	14.0	97.6	177.6	301,892
1963	84.3	82.6	15.7	102.1	88.9	151,206
1964	98.8	83.7	1.2	104.2	568.2	966,807
Average	89.1	84.4	10.9	102.3	173.4[7]	415,959

[1] Weighted by index catch.

[2] Number winters in freshwater.

[3] Mean length in mm.

[4] Base year assigned value of 100.00.

[5] One index point = 1,700.34 smolt.

[6] Adjusted index.

[7] Geometric mean.

Table 7. Condition index of red salmon smolt from the Wood River system using 3 mm length groups, 1964.

Mid-point of 3 mm groupings	Grams per Fish							Mean average
	June 6-10	June 11-15	June 16-20	June 21-25	June 26-30	July 1-5	July 6-10	
70	-	-	-	-	-	2.96	3.40	3.18
73	-	-	-	3.70	3.11	2.78	3.50	3.11
76	3.70	3.46	-	3.55	3.42	3.96	3.89	3.65
79	4.30	4.71	4.19	4.23	4.16	3.90	3.92	4.20
82	3.98	4.61	4.50	4.45	4.71	4.72	4.68	4.53
85	5.25	5.03	5.11	5.00	5.06	5.05	4.82	5.06
88	5.57	5.59	5.61	5.36	5.56	5.68	5.53	5.55
91	6.12	6.07	6.23	6.16	6.15	6.16	6.48	6.17
94	6.83	6.54	6.54	6.52	6.49	6.86	-	6.63
97	7.95	7.29	7.28	7.45	7.00	8.26	-	7.53
100	6.99	7.97	7.51	7.84	8.53	8.44	-	7.86
103	8.55	8.94	8.66	8.02	-	8.84	-	8.60
106	10.15	9.97	-	-	7.53	9.79	-	9.48
109	9.34	10.90	-	8.60	8.68	7.87	-	9.29
112	11.81	10.75	10.49	-	9.90	8.62	-	10.59
115	-	-	-	-	-	11.70	-	11.70
118	-	-	-	-	12.70	-	-	12.70

Table 8. Average lengths and weights of Wood River red salmon smolts by freshwater age groups, 1961-64[1].

Year of seaward migration	Age I		Age II	
	Length	Weight	Length	Weight
1961	81.7	4.3	102.1	7.7
1962	80.1	4.2	97.6	7.9
1963	82.6	5.1	102.1	9.3
1964	83.7	4.8	104.2	8.5
Mean Average	82.0	4.6	101.5	8.4

[1] Weighted by index catch.
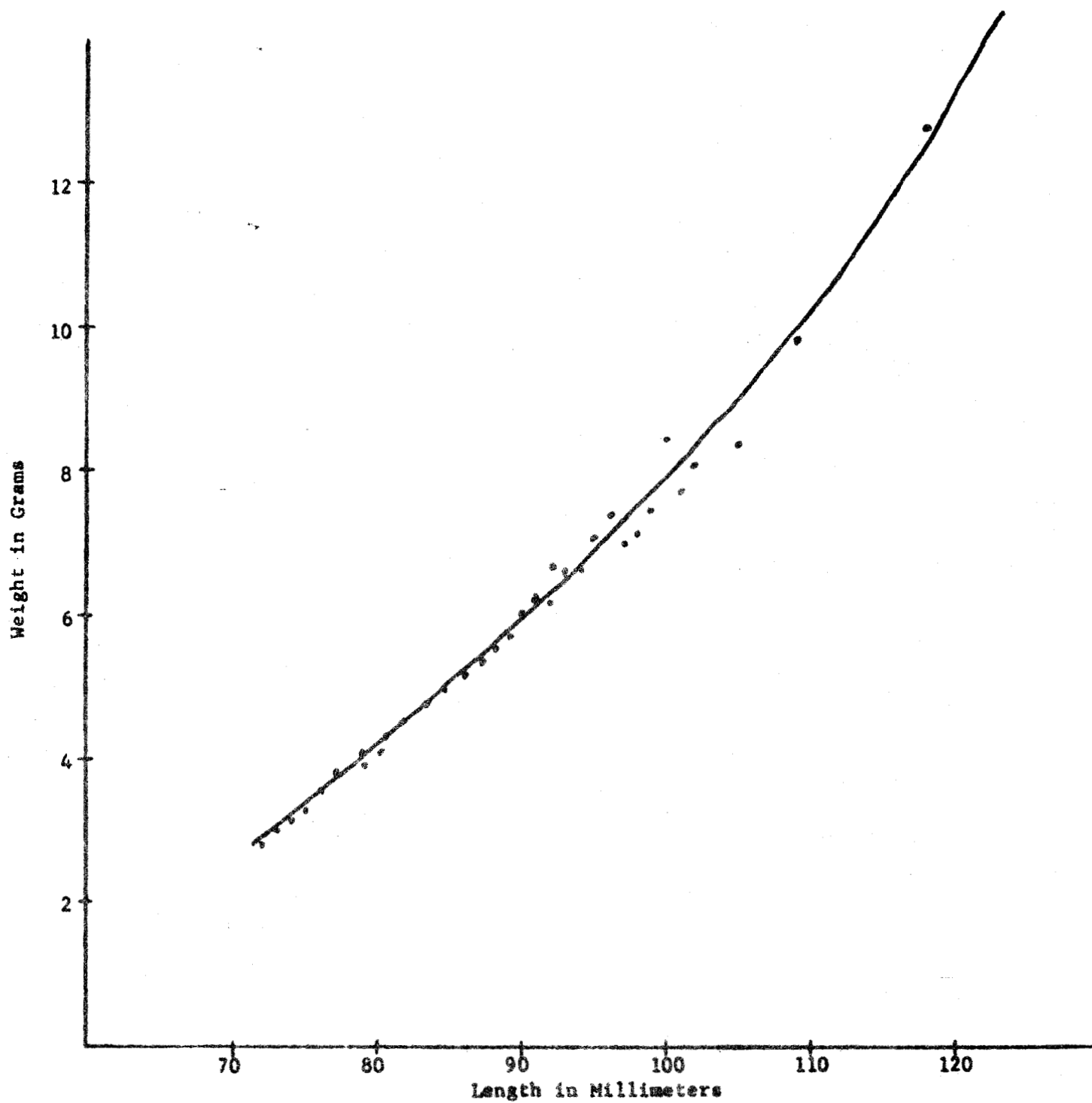
Figure 8. Length-weight relationship of red salmon smolt from the Wood River system, 1964.

Table 9. Percentages of Wood River red salmon smolts parasitized by the cestode, *Triaenophorus crassus*, 1961-64.

Year	Total number of smolt examined	Number of 1 lb. sample examined	Range of 1 lb. sample size	Percent smolt parasitized all samples	Range between samples in percent parasitized
1961	5,467	60	59 - 129	11.9[1]	0 - 27.3
1962	4,789	58	47 - 125	22.8	2.4 - 46.2
1963	4,091	55	44 - 99	26.9	0 - 61.7
1964	5,984	68	64 - 118	54.4	29.7 - 84.1
Mean Av.	5,083	60	54 - 118	25.1[2]	8.0 - 54.8

[1] Parasitized smolt were not counted during first week of seaward migration when percentage is highest. Consequently, percent parasitized, all samples, is a low estimate.

[2] Geometric mean.

The 1962 escapement of 874,000 produced 98.8 percent of the outmigration with the remainder being derived from the relatively low escapement in 1961.

The number of smolts produced by the 1962 spawning is the highest value ever obtained (Table 10). The final smolt production from the 1962 escapement cannot be fully assessed until the Age II smolts leave the Wood River system in the spring of 1965.

The large seasonal migration in 1964 of Age I smolts indicates that the fresh-water survival of the 1962 progeny was very high. Winter egg surveys conducted in 1962-63 by the author in the Wood River lakes revealed that in the majority of the spawning areas sampled, mortalities were less than one percent (Nelson 1964b). The mild winter of 1962-63 led to excellent survival to the fry stage, as evidenced by the large tow-net catches obtained by the Fisheries Research Institute in their tow-netting program on the Wood River lakes.

Table 10 gives the relationship between parent escapements of red salmon to the spawning grounds of the Wood River lakes and relative numbers of smolts produced. The rate of reproduction is represented by the number of smolt-index units per 1,000 parent spawners.

As seen in Table 10, there is no definite relation between the size of escapement and the smolt indices; however, it is apparent that years of large escapement produce more smolts. It may be concluded that seasonally fluctuating conditions for survival are more important than abundance of spawners in determining abundance of smolts.

<center>SUMMARY</center>

1. The Alaska Department of Fish and Game conducted the smolt enumeration and sampling program for the fourth consecutive year in 1964. The program was initiated in 1951 by the Fisheries Research Institute and 1964 marked its 14th consecutive year of operation.

2. The four main Wood River lakes cover approximately 174 square miles of a watershed basin of about 1,415 square miles.

3. The index of smolt abundance was obtained by use of a standard wing-type fyke net and other equipment comparable with previous years. Collection of biological and physical data was extended to cover a wider range.

4. The fyke net was fished during the previously established index hours of 9 to 11 p.m. each night from June 6 through July 20. In addition, several 24-hour counts were made in order to show the relation between diurnal and nocturnal migrations.

5. Breakup occurred on June 15-16 at Lake Aleknagik which was 2 weeks later than normal. Ice floes in the river hindered operations for the first week.

6. The total catch of 966,807 smolts or 568.60 index points was the largest recorded for the Wood River system in 14 years of smolt indexing.

Table 10. Wood River red salmon escapements and smolts produced, 1951-62.

Year	Wood River escapement	Index values of smolts produced			Index units per 1,000 spawners
		Age I	Age II	Total	
1951	458,000	282.2	18.4	300.6	.66
1952	227,000	420.2	4.4	424.6	1.87
1953	516,000	217.3	70.5	287.8	.56
1954	571,000	256.1	31.9	288.0	.50
1955	1,383,000	133.6	80.8	214.4	.16
1956	773,000	150.1	3.9	154.0	.20
1957	289,000	56.6	1.3	57.9	.20
1958	960,000	222.0	36.3	258.3	.27
1959	2,209,000	482.4	24.9	507.3	.23
1960	1,016,000	152.7	13.9	166.6	.16
1961	461,000	74.9	6.8	81.7	.18
1962	874,000	561.8	[1]		

[1] The Age II smolts from the 1962 escapement will not leave freshwater until 1965.

7. The 24-hour fishing schedule gave evidence that the majority of the smolt were caught during the evening hours.

8. Timing of the migration was found to vary with the climate, breakup of lake ice, water temperatures, changes in relative numbers in the sub-population of smolt from the lakes, difference between size and age of smolts and differences in rates of growth.

9. Size composition was determined from length measurements of 5,984 smolts contained in 68 one-pound samples. Age determination was based on readings of 780 scales contained in 39 scale samples.

10. Age I smolts comprised 98.75 percent of the total run and averaged 83.7 mm in length and 4.81 grams in weight. Age II smolts comprised 1.25 percent of the run and averaged 104.2 mm in length and 8.51 grams in weight.

11. Sixteen condition samples taken throughout the season gave evidence that the 1964 smolts were comparable to the mean average for the previous 3 years.

12. The parasitic cestode, *Triaenophorus crassus*, was found in 54.5 percent of the smolts examined. The 1964 percent infestation was over twice that of 1963.

13. The 1964 smolt run originated from the adult escapement of 461,000 in 1961 and 874,000 in 1962.

14. Mild winter conditions in 1962-63 are believed to have resulted in exceptionally good survival to the fry stage of the 1964 smolt.

15. It was determined that seasonally fluctuating conditions for survival may be more important than abundance of spawners in determining abundance of smolts.

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